24 April 2000

TO: All Rapid II Contractors

FROM: RSDO Contracting Officer/ 214.3

SUBJECT: IP-Based Spacecraft Accommodation Study Request for Offer (RFO)

The Rapid Spacecraft Development Office (RSDO) and the Glenn Research Center are releasing this RFO for bid. The proposal due date is 8 May 2000 with placement of the delivery orders on or about 12 May 2000. The Study Statement of Work is available on the RSDO web page http://rsdo.gsfc.nasa.gov.

Any proposals submitted in response to the RFO shall include a firm fixed price for the IP-Based Study effort. An offeror may propose only once for the IP-Based Study and any additional proposals by a single offeror will not be considered.

The Government contemplates evaluating and selecting multiple offers based on the proposals as submitted. Following selection, the Government reserves the right to negotiate corrections for any/all evaluated weaknesses prior to issuing the delivery orders. Offerors shall submit a proposal as described in the Offer Format and Instructions section of this RFO.

We look forward to receiving your proposals. If you have any questions with regard to the IP-Based Study RFO please contact me at (301) 286-7586 or by e-mail at (leif.l.grotos.1@gsfc.nasa.gov).

Original Signed By

Leif Grotos
RSDO Contracting Officer

Title: IP-Based Satellite Accommodation Study   **Date of RFO:** April 24, 2000

Type: Mission Specific   **Date Responses are Due:** May 8, 2000
                                                                        3PM, Eastern

Ordering Clause: G.2   **Required Completion Date:** August 25

Summary: The Glenn Research Center is performing an accommodation assessment to determine the range of suitable architectures and technologies to provide IP-based satellite services. Of primary importance will be to identify critical gaps in technology, where modest investment can make a significant long-term impact on the way NASA Enterprises conduct their space missions The studies will focus on meeting performance requirements of identifying IP-architecture concepts, key technologies and components. The government may award more than one delivery order for this study.

List of Attachments:
A   IP-Based Satellite Accommodation Study Statement of Work
B   Goals for IP-Compliant Spacecraft Services
C   Period of Performance, Schedule, Deliverables and Price

Offer Format and Instructions:
a) The offeror shall submit a narrative that outlines their concept for implementing the IP-Based satellite architecture. The submission must address the proposed approach to fulfilling the requirements of the Statement of Work and meeting the Goals for IP-compliant spacecraft services. Address the changes to you're core system(s), that you propose to use as a basis for this study.
b) Offers are to contain no more than two proposed payment milestones and associated completion criteria associated with the study effort.
c) Page count of about 10 pages, limited to not less than 12 point font. A page is defined as one side of a sheet, 8 ½" x 11", with at least one inch margins on all sides. Fold-out pages may be used where appropriate but each fold-out will count as the equivalent number of 8 ½" x 11" pages rounded up to the nearest whole number. That is: an 11" x 17" fold-out page with printing on one side will count as two pages, whereas an 11" x 20" fold-out page with printing on one side will count as three pages. Illustrations, charts, etc., are all included in the limitation total. The acceptable type fonts are either Times New Roman or Ariel, embedded graphics are to be JPEG or GIF format only and not exceed 500Kb each. Font size for text in figures and tables shall be 8 point or larger. Offerors are cautioned that pages not in compliance with this solicitation instruction will not be considered in the evaluation and will be returned to the offeror.
d) The responses to this RFO shall be in Adobe Acrobat Portable Data Format (PDF). Any offer containing a virus will not be opened or evaluated.
e) Offers must be submitted by the above date and time at the RSDO Web Site (http://rsdo.gsfc.nasa.gov)

Evaluation Factors and Relative Importance:
The evaluation team will use the following factors in selection and award.
The Cost/Price Factor is significantly less important than the combined importance of the Mission Suitability Factor and Relevant Experience and Past Performance Factor. As individual Factors, the Cost/Price Factor is less important than the Mission Suitability Factor but more important than the Relevant Experience and Past Performance Factor.

a) Suitability for the IP-Based satellite
NASA will evaluate the offeror's proposed approach and concept for accomplishing the activities reflected in the SOW and meeting the IP Service Goals (Attachment B). The concept for implementing the IP-Based satellite architecture will be evaluated for applicability to the Earth Science and Space Science Enterprises future missions. Any new heritage or availability, beyond that specified in the IDIQ contract, of space flight components, subsystems, and systems will also be evaluated

b) Price
The reasonableness of the proposed price shall be evaluated including consideration of the funding limitation of $60K per delivery order.

c) Relevant Experience/Past Performance
Experience in Internet engineering principals and practices and awareness of existing and planned related systems will be evaluated. Any new relevant experience or past performance beyond that submitted in the RSA proposals will be examined.

Non-Government Evaluation Personnel List:

1. Dr. Glenn Prescott (U.S. Citizen), Assoc. Professor of Electrical Engineering; University of Kansas

Attachment A:

IP-Based Satellite Accommodation Study
Statement of Work

Proposed Study Topic

NASA seeks to leverage the tremendous investment made in the terrestrial Internet by flying commercially obtained satellites whose primary bus and payloads are IP-based and capable of directly interfacing with commercial IP networks. This quick look study will investigate the readiness of commercial satellite system architectures and communications technologies to support the needs of NASA's near-Earth missions over the next ten to fifteen years. Its primary purpose will be to identify critical gaps in technology, where investments in applied research and proof-of-concept development in communications and networks technologies can make a significant long-term impact on the way NASA Enterprises conduct their future space missions.

Background Rationale

The need for such a study is evidenced by several factors. The increase in number, complexity, and frequency of space missions proposed by the Enterprises is expected to continue. Some missions are expected to have collections of sophisticated instruments working in tandem, while others may fly in formations or constellations to accomplish their scientific mission. As spacecraft become more autonomous and capable, it is anticipated that NASA's aggregate telecommunications requirement will be in danger of exceeding the available and projected NASA resources.

National Space Policy directs NASA to begin a transition to commercially provided communications services. The emergence and rapid growth of advanced terrestrial telecommunications, wireless services, and the Internet offer opportunities for NASA to leverage these significant commercial accomplishments. Yet, it is also acknowledged that there are significant gaps in the currently available technologies that will be required to fully enable a Space Internet vision, where every spacecraft system element and instrument becomes a node, addressable in a secure fashion from the ground as easily and autonomously as current terrestrial systems are. The purpose of this study will be to identify those gaps to provide input for a rational plan for their closure.

Desired Results and Use

This quick look study will identify the core bus spacecraft technologies (command and data handling, communications, data storage, on-board instrument interface, etc…) that will be required to "close the gaps" to enable NASA to inter-operate with commercially available components and technologies. Specific topics will be identified for basic and applied research and development in materials, components, and techniques leading to potential breakthroughs in capacity, efficiency, size, mass, power, and connectivity. The

results of this study will be used to identify gaps in technology and provide focus for NASA's efforts over the next 10 years.

Study Approach

The potential for RSA satellite interoperability with communications service providers using Internet Protocols will be studied. The general schema for the study will be:

> 1. NASA will provide a set of goals (Attachment B) for an IP-compliant spacecraft services,
> 2. Contractor shall evaluate their proposed commercial spacecraft bus architecture in light of the new goals,
> 3. Contractor shall identify components that will allow interoperability with the new goals,
> 4. Contractor shall identify key technologies and components required to implement the satellite bus architectures that do not currently exist or whose present terrestrial form does not accommodate space qualification,
> 5. Contractor shall identify the implications of the new IP-based architecture on future integrated satellite operations.

An assumption is that the problem falls into three main areas:

> 1. *Architectures* for interfacing satellite IP nodes to commercial IP networks.
> 2. *Technologies* for spacecraft, space networks, and ground stations to exploit Internet protocols.
> 3. *Systems Engineering Elements* for the interoperability of networked spacecraft, space networks, and ground stations.

Architectures covers topics such as how near-Earth satellites might interface with space-based satellite and/or ground-based network systems (either commercial or government).

Technologies covers advanced component technologies that enable satellites act as nodes such as:

- Modems.
- Codecs.
- Switches.
- Routers.
- Encryptors.
- Firewalls.
- Processors.

S*ystems Engineering Elements* involved in the study include:

- Protocols, algorithms, and standards.

- Network security.
- Satellite operations.

Life cycle issues (technology insertion and obsolescence)
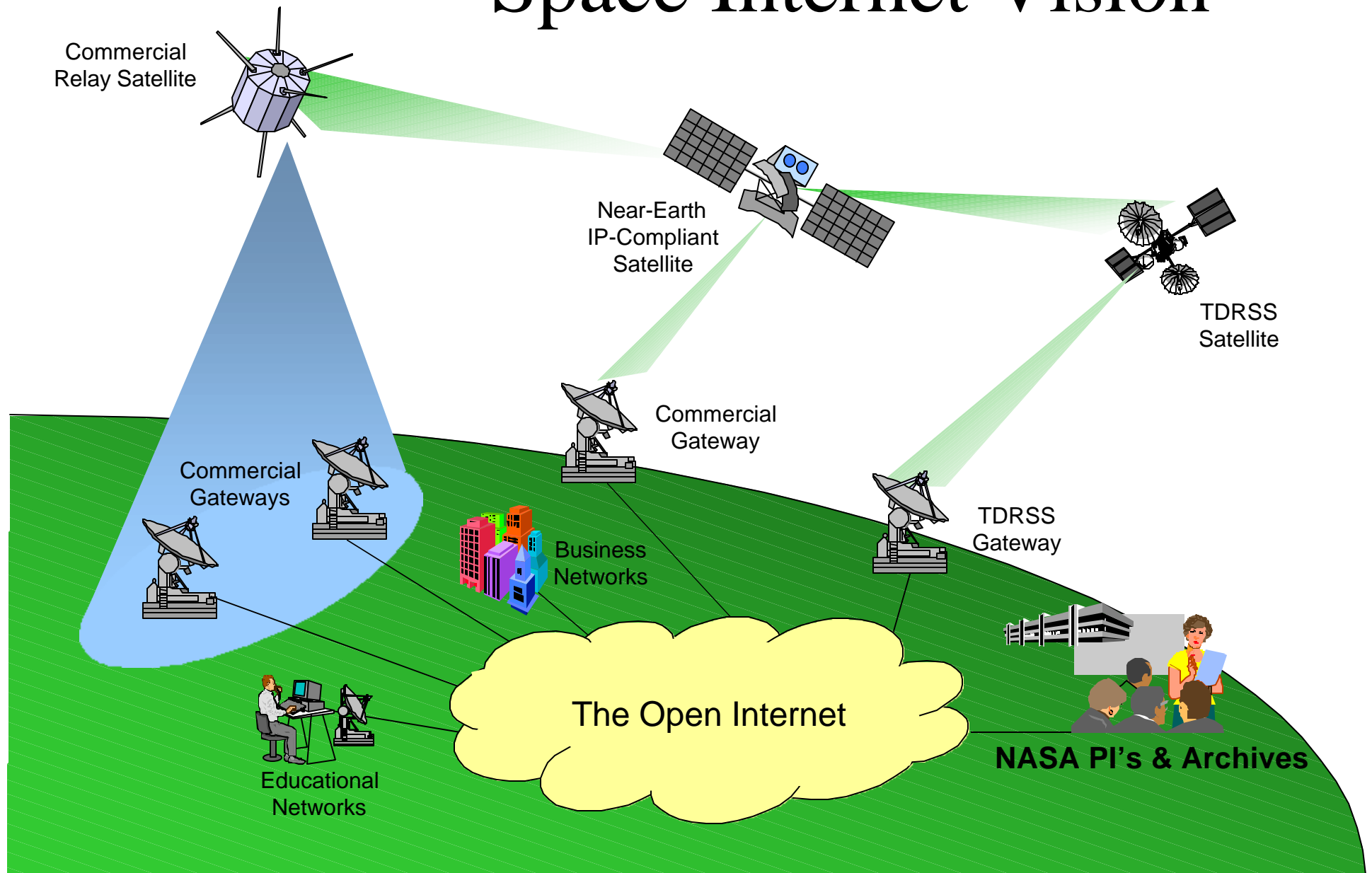
Attachment B:

Goals for IP-Compliant Spacecraft Services

1. End-to-end transparent user operations from a near-Earth, IP-compliant satellite to ground-based users over conventional terrestrial IP network systems using one or any combination of several of the communications paths described below:
   a. Data relay over existing government satellite-based systems (satellite to satellite to ground).
   b. Data relay over existing or planned commercial satellite-based systems (satellite to satellite to ground).
   c. Data distribution directly to existing or planned commercial ground systems (satellite to ground).
   Note: it should be assumed that the near-Earth, IP-compliant satellite is <u>not</u> in constant communication with either the ground or a relay satellite.

2. Communications Network operations for spacecraft and ground systems without intermediate intervention. The end users are Satellite Controllers and Principal Investigators .

3. Allowable system data rates, delivery latency, connectivity (i.e. on demand or scheduled), and addressing / routing issues are open for vendor interpretation. Current NASA mission data down links range from 1 to 150 MBPS, future missions are expected to range from 3 to 600 MBPS.   Latencies range from 3-10 msec for critical control information to many seconds for multi-megabyte science data transfers.

4. Direct IP application layer data transport between spacecraft instrument(s) and the Principal Investigator (PI).
   a. Direct user control of payload instrument from PI ground location.
   b. Autonomous routing of instrument data directly to PI ground location.
   c. Autonomous instrument requests for power, data storage, pointing control, or communications channel on-board the satellite.

5. Emphasis on current and emerging Commercial Off-the-Shelf (COTS) technologies wherever practical.
   a. Network hardware (network interfaces, local area networks, routers, etc…).
   b. Network protocols (compliance with IETF standards, etc…).
   c. Network Topologies

6. Emphasis on open or industry standard interfaces to allow instrument interoperability across a broad cross-section of satellite types, makes, and models.

7. Enable combinations of IP router and mobile intra-constellation communications where collections of sophisticated instruments work in tandem or fly in formations to accomplish their scientific mission.

Space Internet Vision

Commercial Relay Satellite

Near-Earth IP-Compliant Satellite

TDRSS Satellite

Commercial Gateway

TDRSS Gateway

Commercial Gateways

Business Networks

The Open Internet

Educational Networks

NASA PI's & Archives

Attachment C
Period of Performance, Schedule and Deliverables

The period of performance for this study shall be nominally 100 days after receipt of order (ARO).

Study Schedule, Meetings and Location

Date	Activity	Location	Duration
Within 7 days ARO	Kick-off meeting	Contractor's location	½ day
Within 50 days ARO	Mid-term Status Review	Via telcon	2 hours
Within 100 days ARO	Final Presentation	NASA GRC location	½ day
As needed	Informal exchanges	Via telecon & e-mail	

Deliverable shall be one vugraph presentation describing the findings from the study

Distribution

Upon completion of the study copies of the presentation shall be distributed to the following recipients:

4 paper copies of the study shall be delivered to:

> Phillip E. Paulsen
> Mail Stop 54-6
> NASA Glenn Research Center
> 21000 Brookpark Road
> Cleveland, Ohio 44135

1 paper copy and 1 electronic media copy of the study shall be delivered to:

> Contracting Officer
> Mail Code 214.3
> NASA Goddard Space Flight Center
> Greenbelt, MD 20771

Delivery Schedule

Date	Item	# of Copies
Within 100 days ARO	Final report	5 hard copies and 1 on electronic media

Price

The NASA envisions two equal payments:

Payment 1 at completion of mid-term status review	$_tbp__
Payment 2 at NASA acceptance of Final Report	$_tbp__
Total	**$_tbp__**